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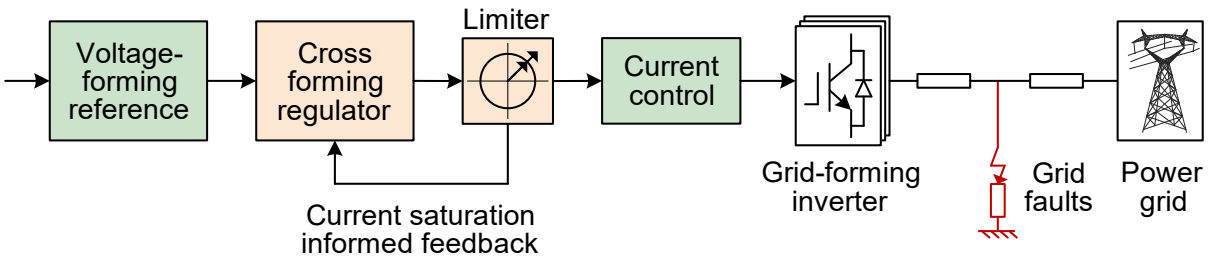
Licensing Opportunity

Fault ride-through and current limiting control of grid-forming inverters under grid faults



The controller comprises four modules, where the cross-forming regulator along with the current limiter preserves the voltage angle forming behavior and enforces the current magnitude forming behavior.

Application

This invention enables power inverters to control their *current magnitude* and *voltage angle* (i.e., "cross-forming"). With this, grid-forming inverters can quickly limit fault currents at a prescribed level and preserve voltage angle forming for grid synchronization and dynamic ancillary services provision (e.g., fault reactive current injection), during symmetrical or asymmetrical fault ride-through.

Features & Benefits

- Current magnitude forming and voltage angle forming
- Fast, able to fully utilize the overcurrent capability, adaptable to various disturbances, simple to implement, easy to tune, and robust in stability performance
- Constant virtual impedance facilitates stability analysis

Publications

- "Saturation-informed current-limiting control for grid-forming converters," *Electr. Power Syst. Res.*, 2024, 10.1016/j.epsr.2024.110746
- "Cross-forming control and fault current limiting for grid-forming inverters," submitted, 2024, arXiv.2404.13376
- Patent pending

transfer

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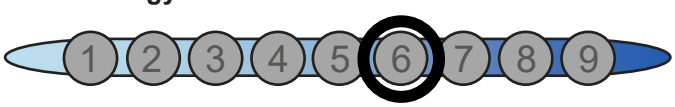
Technology Readiness Level



Background

Limiting the current of grid-forming inverters during grid disturbances is vital to prevent potential overcurrent damage. Moreover, grid-forming inverters should maintain grid-forming synchronization and supply ancillary services during fault ride-through as continuously as possible to satisfy the requirements of grid codes, even when the current reaches the limit. The technical challenge widely acknowledged in this regard involves limiting fault current, maintaining transient stability, and providing ancillary services simultaneously. Since grid-forming inverters play a crucial role in future grids and will be widely deployed in generation, transmission, distribution, and energy storage systems, there is a huge market need for high-performance grid-forming inverter products.

Invention

The controller comprises four modules (see the figure). The voltage-forming reference module aims to provide a voltage-forming reference. The cross-forming regulator module takes the voltage-forming reference, the voltage measurement, and the current saturation-informed feedback to generate a current reference based on a virtual admittance relationship. Thus, it ensures that the voltage angle forming behavior behind the virtual impedance is preserved, and meanwhile, the voltage magnitude is adaptively changed depending on overcurrent conditions. Furthermore, the current limiter enforces fast current magnitude limiting, and the inner current controller achieves fast current tracking. In this way, the controller enables grid-forming inverters to safely and stably ride through grid faults and quickly provide ancillary services such as fault currents. Moreover, the resulting virtual impedance is constant, allowing users to directly apply existing methods for transient stability analysis. The control code of this invention has been tested and validated in a prototype converter laboratory platform.